

Chapter 6.0 Biogenic Emissions

6.1 WHAT EMISSIONS DATA DOES EPA PRESENT IN THIS CHAPTER?

This chapter presents preliminary biogenic volatile organic compound (VOC) and nitric oxide (NO) emissions for 1988, 1990, 1991, 1995, 1996, and 1997. Estimates for 1998 are not available because the United States (U.S.) Environmental Protection Agency (EPA) did not have the resources to develop biogenic estimates for that year. The 1998 estimates will be included in the 1999 Trends report. Tables 6-1 and 6-2 show VOC and NO emissions, respectively. Tables 2-1, A-2, and A-3 do not contain the biogenic emission estimates because EPA only tracks anthropogenic emissions for regulatory purposes.

6.2 HOW WERE THESE EMISSIONS GENERATED?

EPA calculated the biogenic emissions for 1988, 1991, 1995, 1996, and 1997 using the Biogenic Emissions Inventory System - Version 2 (BEIS2).^{1,2,3} EPA used a slightly different version of BEIS2 to generate the 1990 estimates.

6.3 WHY DO THESE EMISSIONS VARY?

Differences in climatology (i.e., temperature and cloud cover) and land use strongly affect biogenic emissions.

6.7 REFERENCES

1. Birth, T., "User's Guide to the PC Version of the Biogenic Emissions Inventory System (PC-BEIS2)," EPA-600/R-95-091, U.S. Environmental Protection Agency, Research Triangle Park, NC. 1995.
 2. Geron, C., A. Guenther, and T. Pierce, "An Improved Model for Estimating Emissions of Volatile Organic Compounds from Forests in the Eastern United States," *Journal of Geophysical Research*, vol. 99, pp. 12773-12791. 1994.
 3. Williams, E., A. Guenther, and F. Fehsenfeld, "An Inventory of Nitric Oxide Emissions from Soils in the United States," *Journal of Geophysical research*, vol. 97, pp. 7511-7519. 1992.
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6.4 HOW DOES TEMPERATURE AFFECT EMISSIONS?

Annual emissions correlate very strongly with changes in annual temperature patterns. The highest emissions levels occur in the summer when temperatures rise the highest. An increase of 10°C can cause over a two-fold increase in VOC and NO emissions. Tables 6-3 and 6-4 show the seasonal allocation of VOC and NO emissions, respectively.

6.5 HOW DOES LAND USE AFFECT EMISSIONS?

Variations in land use can greatly affect spatial variation in biogenic emissions densities. In the southern United States and Missouri, large areas of oak trees show high VOC densities, while in the midwestern United States, areas of fertilized crop lands show relatively high densities of NO. Figures 6-1 and 6-2 show the spatial variation in biogenic emission densities across the United States.

6.6 WHAT IS THE UNCERTAINTY ASSOCIATED WITH THESE ESTIMATES?

These estimates have an uncertainty factor of a maximum of two. However, biogenic emissions research continues to be quite active, and EPA expects improvements in these emission estimates in the next few years.

**Table 6-1. Biogenic Volatile Organic Compound Emissions by State
(thousand short tons)**

State	1988	1990	1991	1995	1996	1997
Alabama	1,826	2,114	1,852	1,937	1,597	1,579
Arizona	535	542	517	548	591	545
Arkansas	1,837	1,852	1,476	1,741	1,472	1,517
California	1,815	1,778	1,711	1,794	2,125	1,623
Colorado	889	748	817	826	878	786
Connecticut	81	68	74	81	63	68
Delaware	25	19	24	26	20	21
District of Columbia	1	1	1	1	0	1
Florida	1,352	1,513	1,246	1,436	1,255	1,307
Georgia	1,666	1,958	1,609	1,721	1,454	1,405
Idaho	854	810	764	706	726	726
Illinois	283	227	257	244	191	187
Indiana	237	185	227	218	165	157
Iowa	141	95	103	112	89	93
Kansas	154	140	133	118	116	119
Kentucky	677	575	648	636	496	464
Louisiana	1,291	1,403	1,043	1,367	1,125	1,187
Maine	599	567	621	622	531	453
Maryland	164	132	155	169	127	135
Massachusetts	140	107	129	140	109	119
Michigan	581	422	548	533	394	408
Minnesota	729	519	612	636	533	502
Mississippi	1,662	1,801	1,450	1,642	1,402	1,419
Missouri	1,472	1,222	1,298	1,267	1,056	1,045
Montana	912	729	781	666	716	680
Nebraska	95	79	81	78	72	77
Nevada	152	140	142	135	158	126
New Hampshire	168	147	163	171	137	286
New Jersey	130	115	124	132	103	107
New Mexico	505	533	499	531	544	440
New York	350	303	328	361	280	290
North Carolina	1,072	1,194	1,002	1,110	908	882
North Dakota	69	49	51	48	46	50
Ohio	270	211	243	259	197	183
Oklahoma	1,013	1,016	864	887	836	811
Oregon	1,066	1,118	1,002	1,114	1,087	1,075
Pennsylvania	594	510	560	642	460	473
Rhode Island	24	18	21	24	18	20
South Carolina	738	886	652	755	626	632
South Dakota	142	103	113	104	102	102
Tennessee	1,063	1,022	1,010	997	817	781
Texas	2,711	2,864	2,244	2,649	2,481	2,431
Utah	407	374	353	345	410	324
Vermont	102	91	100	106	88	90
Virginia	911	886	850	917	728	714
Washington	685	780	650	801	735	763
West Virginia	510	420	473	492	383	368
Wisconsin	648	450	516	541	412	398
Wyoming	505	387	397	358	396	223
National	33,852	33,224	30,536	32,742	29,254	28,194

NOTE: The sums of States may not equal National total due to rounding.

**Table 6-2. Biogenic Nitric Oxide Emissions by State
(thousand short tons)**

State	1988	1990	1991	1995	1996	1997
Alabama	14	19	14	14	14	14
Arizona	55	51	53	55	58	55
Arkansas	19	21	19	19	18	18
California	42	40	42	42	44	41
Colorado	39	35	38	38	39	35
Connecticut	1	1	1	1	1	1
Delaware	2	2	2	2	2	2
District of Columbia	0	0	0	0	0	0
Florida	22	29	22	22	22	22
Georgia	19	29	20	20	19	19
Idaho	25	23	24	24	24	24
Illinois	90	84	90	86	81	82
Indiana	49	48	51	49	46	46
Iowa	93	82	90	87	81	85
Kansas	91	87	91	85	83	85
Kentucky	19	20	20	19	18	18
Louisiana	19	20	19	19	19	19
Maine	3	3	3	3	2	2
Maryland	6	6	6	6	6	6
Massachusetts	1	1	1	1	1	1
Michigan	25	25	26	25	23	24
Minnesota	58	52	56	54	50	53
Mississippi	19	22	19	19	19	18
Missouri	44	42	44	42	40	40
Montana	60	49	57	53	52	50
Nebraska	91	83	90	86	80	85
Nevada	46	38	44	44	47	41
New Hampshire	1	1	1	1	1	2
New Jersey	2	2	2	2	2	2
New Mexico	62	59	61	64	65	56
New York	17	19	18	18	17	17
North Carolina	21	26	22	21	20	20
North Dakota	51	42	48	44	43	47
Ohio	36	36	37	35	33	33
Oklahoma	35	37	35	34	34	33
Oregon	24	22	23	23	23	23
Pennsylvania	19	21	20	20	18	19
Rhode Island	0	0	0	0	0	0
South Carolina	10	16	11	11	10	10
South Dakota	62	53	60	56	52	56
Tennessee	17	18	18	17	16	16
Texas	199	203	199	202	206	195
Utah	28	25	27	28	29	23
Vermont	2	2	2	2	2	2
Virginia	10	12	10	10	9	9
Washington	15	15	14	15	15	15
West Virginia	4	4	4	4	3	3
Wisconsin	36	34	35	35	32	33
Wyoming	39	40	36	35	35	28
National	1,638	1,596	1,628	1,591	1,553	1,529

NOTE: The sums of States may not equal National total due to rounding.

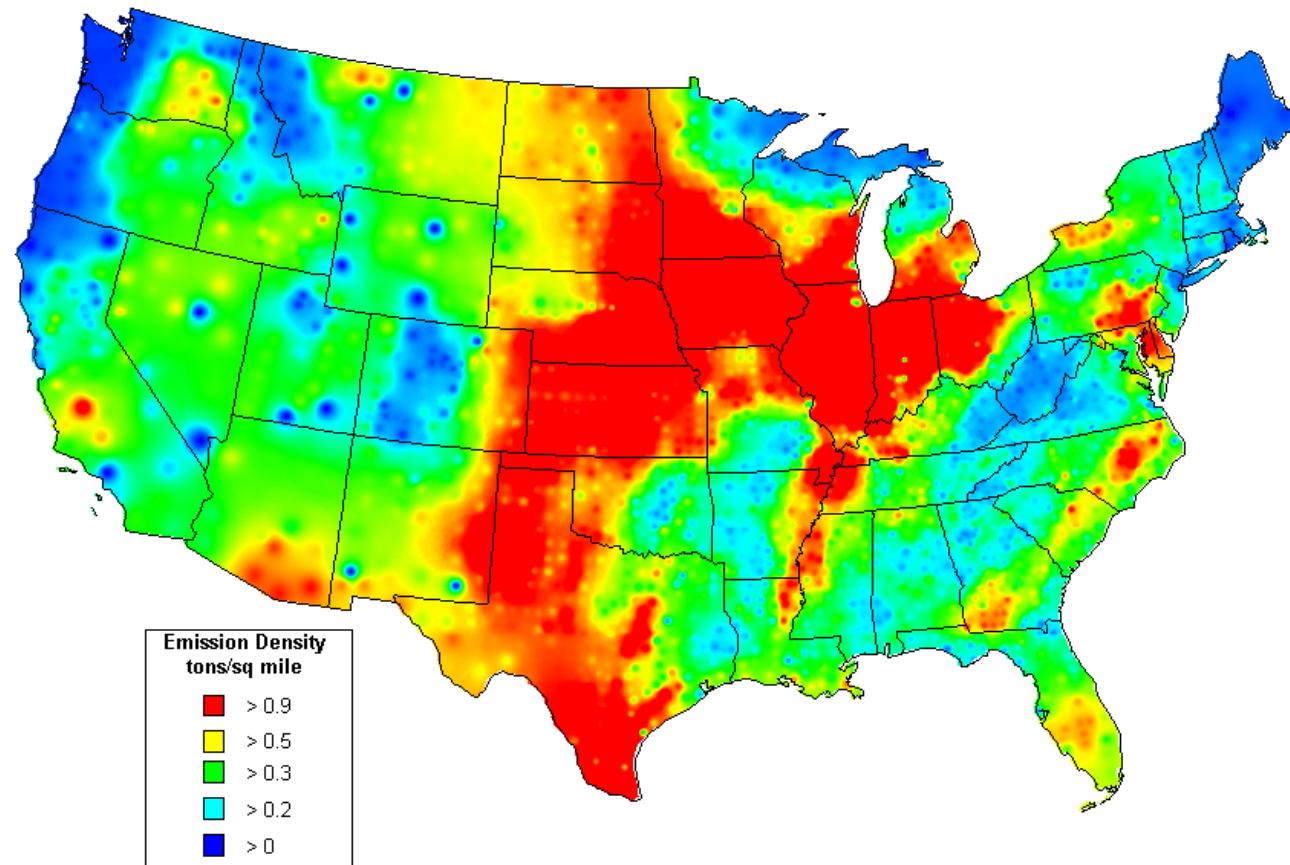
Table 6-3. Biogenic Volatile Organic Compound Seasonal Allocation, 1988 to 1996 (percentages)

Year	Winter	Spring	Summer	Autumn
1988	3	18	61	18
1990	4	17	57	22
1991	3	21	62	14
1995	3	18	59	19
1996	3	19	58	20

Table 6-4. Biogenic Nitric Oxide Seasonal Allocation, 1988 to 1996 (percentages)

Year	Winter	Spring	Summer	Autumn
1988	11	23	42	24
1990	15	21	39	25
1991	12	24	40	23
1995	12	22	41	24
1996	12	23	41	24

**Figure 6-1. Density Map of NITROGEN OXIDES 1997
Biogenic Emissions by County**



**Figure 6-2. Density Map of VOLATILE ORGANIC COMPOUND 1997
Biogenic Emissions by County**

